SILVICULTURE

Report of a Forestry Mission to British Columbia 1991

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Report of a Forestry Mission to British Columbia 1991

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Acknowledgement

For various reasons, both of us have had the privilege to visit British Columbia many times since the 1950's. However, the common denominator of our B.C. contacts is forestry and forest industry. During this long time we have had opportunities to witness the changes in the B.C. society and the development of its forest sector. Needless to say, even apart from our professional relationship, we have long since lost our hearts to "Beautiful British Columbia."

Therefore, John R. Cuthbert, Chief Forester of the B.C. Forest Service, had no difficulty in enticing us into travelling to B.C. to visit forestry activities and to meet colleagues for discussions of current issues. Not even the expectations of a written report on observations could discourage us from taking this chance to strengthening old links between Swedish and B.C. forest sectors.

The itinerary was excellently arranged by the Forest Service staff in Victoria and everything fitted in. We had many elucidating meetings with the Administration and the field staff, starting with a breakfast meeting in Victoria on May 27, hosted by the [then] Honourable Claude Richmond, Minister of Forests, and concluding with a press conference at Seymour Demonstration Forest on June 7. The well-prepared and informative field excursions in several Forest Regions initiated us into current policy and management issues to be discussed. The openness of our hosts was very stimulating. Wherever we arrived, the hospitality was unforgettable.

Many people of the Forest Service, industry, and other groups contributed to arranging and accomplishing this mission. We met so many persons at the various points in the program that we, faced with the risk of missing some names, have decided not to list our hosts in this context. To all of them we want to express our hearty thanks. None mentioned — none forgotten.

However, we cannot refrain from singling out two persons of special importance to the mission, namely John R. Cuthbert, the initiator, and Ralph Huber, our indefatigable guide on the tour.

In submitting our mission report, we hope that it will contribute to continued professional interchange between foresters of all categories in Canada and Sweden. We have many mutual interests; and we have lessons to learn from each other.

Stig O. A. Hagner and Hugo von Sydow
Stockholm and Sundsvall, September 1991

Executive Summary

In May 1991, the Ministry of Forests, Silviculture Branch, gave an assignment to us to study the forestry of British Columbia. The task included visiting several Forest Regions, giving information to Forest Service staff, representatives of industry, and other interest groups on relevant Swedish forest policy, and comparing and contrasting Swedish and British Columbia policies and practices. Our observations and recommendations are outlined in this written report.

There is an old relationship between the forest sectors in British Columbia and Sweden, with a frequent professional exchange. Similarities in basic conditions unite us in fruitful co-operation in many fields. When discussing the need for a strengthened forest inventory in the report, we submit that an institutional contact should be established with counterparts in Finland and Sweden, involving, for example, the exchange of visiting researchers with the Department of Forest Survey, the University of Agricultural Sciences in Sweden.

There are also important differences between British Columbia and Sweden, which one must remember when comparing our countries — not only differences set by Nature. Issues, directly related to institutional and legislative circumstances, will not be discussed in this report. However, one distinction must constantly be kept in mind: ownership. In Sweden, 50% of the forested land is owned by private individuals (the main proportion consisting of small woodlots, often in combination with farming), 24% by forest products companies, and the balance by the State, communities, and so on. Also the industry is mainly in private hands. It is compelled to obtain the bulk of its timber requirements on the open market in free competition. These conditions have a decisive effect on the creation and implementation of forest policy and management regimes. The private ownership is regarded as the best incentive to investment in incremental forestry.

In British Columbia, tenure systems that secure long-term timber supply should be the best stimulus to successful accomplishment of renewal programs.

Contrary to the development in British Columbia, Sweden, with no remaining old growth, has been forced for many decades to make full use of its resources and to reinvest extensively in sustained silviculture. The industry has successively adjusted itself to a changing raw material supply, increasing timber and production costs, and strong international competition. The basic forestry philosophy is "to provide permanently high and valuable timber yield. This management should pay heed to nature conservation and other interests." Growing stock and growth rates are today the highest ever, and they continue to increase.

British Columbia forestry has traditionally been directed towards harvest and utilization of old growth, supplying the industry with a selection of quality timber. Due to previous harvesting practices and insufficient reforestation, there is an overall lack of young and middle-aged resources. In many areas of the province, the industry is now facing a decline in supply of accessible old growth of commercial qualities and a considerable rise in costs. Environmental demands will further limit the land base for industrial timber production.

Forestry in British Columbia is now in a transition phase. Regionally, many mills must adapt to a changing mix of species, qualities, and sizes. Supply and cost factors attest to the need to recover more commercial timber from each management unit, especially those units within short hauling distance to the mill. One consequence is evident: an increased interest in intensive forestry practices, including thinnings, and hence in utilization of small-sized roundwood. Environmental considerations will press in the same direction.

In this new situation there is an urgent need for better and more detailed knowledge about existing resources. It is more important than ever to improve the data base for calculations on growth and yield in future managed stands. Not until such a reliable inventory has been established can legislators and decision-makers possess the instrument for creating a forest policy and strategic planning. Not until then can a comprehensive allowable annual cut (AAC) be decided on for the whole province and for specific management units.

The key recommendation is to concentrate collecting, compiling, and analyzing of all forestry data in a strengthened, permanent forest inventory. The institution should be located at the government body responsible for the integrated management of forest resources and be backed by an advisory committee with representatives of relevant groups concerned. The inventory should also compile forecast data on the demand side as a basis for timber balances.

In light of the Swedish experience, comments are made as well on present incremental silviculture practices in British Columbia.

The new thinking in forestry (verbalized in "The Forest Renewal Program") will call for great efforts and funds. To a large extent, success will spring from systematic planning, knowledge, and skill at all levels of the forest establishment. Not only professional education and vocational training are required, but also good understanding and know-how in practical, site-related management. Formal vocational training of silviculture workers is an important requirement, too.

There is broad consensus for the need for sustained development of natural resources. The forest products industry will remain as the key element of the province's economy. The overall mission of forestry is to ensure a long-term timber supply. In doing this, it is the responsibility of the forest sector to heed biodiversity and other values of forested land. Research, education, information, and good will are prerequisites for combining these goals.

The government, the forest industry, nature conservancy groups, and other interests concerned, independently as well as in joint efforts, must continue to inform and involve the public in all of these forest issues.

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Introduction

In May 1991, we were contracted by the Ministry of Forests, represented by Mr. John R. Cuthbert, Chief Forester, to do the following:

- visit various Forest Regions and forestry activities
- meet with Forest Service staff, representatives of the industry, other relevant groups, and media
- provide information on development and implementation of Swedish forest policy, environmental issues, and forest management
- study and discuss the state of forestry and forest practices in British Columbia
- compare and contrast Swedish and British Columbia policies and practices
- at the completion of the tour, outline our observations and make recommendations in a written report.

During our study, we referred to the B.C. Forest Renewal Program and to the report "The Future of Our Forests," published in April 1991 by the Forest Resources Commission. We were also aware of the keen public interest to compare Sweden and British Columbia in their forest practices and environmental considerations.

In 1989, representatives from the B.C. Ministry of Forests, Forestry Canada, and the Northern Interior Lumber Sector of the Council of Forest Industries (COFI) participated in a Forestry Mission to Sweden and Finland. They published (as FRDA Report 156, March 1990) what is, in our opinion, a concentrated but correct and exhaustive description and discussion of Swedish forestry, raising most of the issues which we deal with in this paper. To save space in this context and time for many readers of our report, we do not repeat all the basics here. In the overview of Swedish features, we restrict ourselves to circumstances of particular importance to our comments on the British Columbia policies and practices.

Literally interpreted, the terms of reference of the assignment are very broad in scope. We are well aware that many issues, which are described in the public debate as discrepancies and as constraints of long-term planning in the forest sector, originate in institutional conditions, such as:

- the relationship between Ottawa and British Columbia concerning forest ownership and policy-making;
- distribution of responsibilities among several government bodies for the sub-sectors within forestry, forest industry, and markets; and
- uncertainty between government and industry as to the long-term, common goal of land use and forest utilization, including future tenure systems.

Our assignment, however, did not include discussion of these issues.

Even though the field tours and all the information we received were very instructive, and even though we started from a reasonable educational level, it must be kept in mind that we were visitors. We feel, therefore, that we were supposed to concentrate on those practical policy issues and forestry practices of topical interest in British Columbia to which our hosts particularly called our attention.

The report is a result of our joint efforts. However, mainly responsible for Chapter 4 and Chapter 5 is von Sydow and Hagner, respectively.

Swedish forestry: the state in a flash, as of Summer 1991

One of the primary purposes of our mission was to compare Swedish and British Columbia forestry policies and practices related to some debated issues. Forestry is a long-term business and forestry policy must be created accordingly. At the same time, the sector is dynamic, being influenced by economic, social, and technical development, domestic as well as international.

In comparing these two systems, one has to keep in mind that the issues discussed must be related to about the same stage of development in the countries. We therefore feel justified in briefly describing the current state of the Swedish forest sector.

- Of great significance to the export-oriented industry, and thus to the sector as a whole, is our application for membership in the European Community (EC) and the negotiations between the EC and Economic Free Trade Agreement (EFTA) on the establishment of a European Economic Area. Over the last few years, Swedish corporations have made heavy investments in the EC forest sector.
- The present recession is having a considerable impact on the industrial activities. In addition, we are reminded of new forest product players, new competing products, and increasing competition from traditional rivals.
- Due to slackened demand, increased production costs, and lower prices, the forest products industry is cutting production and running with unsatisfactory profitability. The same is true for the wood industry as well as — with some variations — the pulp and paper sector.
- Impressive reductions in process emissions to the environment have been recorded, resulting from long-term research and very heavy investment in the mills. Ongoing and planned activities will further reduce the emissions necessary to meet new government regulations.
- As a result of several decades of intensive forest management, the forest assets are greater than ever; standing volume as well as annual growth and potential cut will continue to increase. The raw material supply will allow further expansion of the industry.
- Forest management expenditures remain high. Some 200 000 ha will be planted; vegetation control and spacing amount to more than 365 000 ha and thinning of young stands to 300 000 ha per year.
- Due to current industry slow down, demand of timber has decreased from past years. Although the import of roundwood and chips has been curtailed, there is an excess of supply on the domestic timber market. The prices are declining and the forest owners are facing lower stumpage value and deteriorating profitability.
- In the long-term, forestry appears to have a good future. When the balance is restored between supply and demand of forest products and the economy has recovered, an efficient industry and solid timber supply will guarantee a sustained positive development.
- The forestry R & D has been assigned additional resources, primarily to intensify research on matters of management practices and environmental consequences.
- Continuous rationalization and the present recession have caused transfers and lay-offs of employees in forestry and industry. That may partly explain why the recruitment to the vocational training for forest workers has been unsatisfactory during the past years.
- With general election to the Parliament at hand, other domestic and Europe-related issues have dislodged the public environment debate from first-page headlines. However, as far as forestry is concerned, there is a keen interest in the land use. The preservationists question the intensive, commercial forestry in light of other values of the resource. Some pressure groups also propose increased and more detailed statutory rules to restrict the use of intensive management measures.
- Forestry has closed ranks in claiming the responsibility for the environment must rest on that sector and the foresters. They have the skill and the motivation. The Forest Act gives sufficient guidelines. Detailed directions in the overall land use legislation concerning environmental considerations in forestry will result in bureaucracy and unnecessary costs.
- In the Terms of Reference for the Parliamentary Committee now working on evaluating the forest policy, it is stated that the forest industry will continue to be the backbone of Sweden's economy and will contribute to growth more than ever. Therefore, land that is of importance to the forest industry must be protected from measures that are detrimental to efficient forestry. In formulating the goals of the future forest policy, the committee shall also take into account that the forests must be managed to safeguard the sustainability of the available natural resources and the protection of species and natural environments. This calls for planned land use, environmentally sound forestry techniques and higher priority for environmental protection and nature conservation.

British Columbia and Sweden: some comparative basics and features

When discussing a possible application of Swedish experience to British Columbia circumstances, one must keep some basic facts in mind.

In the previously mentioned FRDA Report 156, "Report of a Forestry Mission to Scandinavia," there is a table of comparative statistics for Sweden and British Columbia. With minor supplements, that table is quoted below (Table 1).

Table 1. Comparative statistics for Sweden and British Columbia

	Sweden	British Columbia
Population	8.4 million	3.1 million
Total forested area	26 million ha	52 million ha
Working forest	23 million ha	28 million ha
Forest ownership		
- public	26 %	94 %
- companies	24 %	5 %
- individuals	50 %	1 %
Standing volume[a]	2700 million m³*	8900 million m³
Species		
- spruce	47 %	23 %
- pine	38 %	19 %
- deciduous	15 %	4 %
- others	0 %	54 %
Allowable (or potential) annual cut[b]	90 million m³*	74 million m³
Current annual harvest[b]	67 million m³*	74 million m³
Annual production		
- wood products	12 million m³	39 million m³
- pulp	11 million tonnes	7 million tonnes
- paper	9 million tonnes	3 million tonnes
Forest employment		
- direct	142 000	87 000
- indirect	70 000	174 000

[a] (*) If not otherwise stated, the Swedish measure of volume, growth, AAC, etc., is forest cubic metre (in Swedish abbreviated m³sk), which means the stem volume, including bark above the stump.

[b] Sweden and Finland use the concept of potential, rather than allowable, annual cut. British Columbia figures for allowable cut and annual harvest are for Crown-regulated lands only. The cut from private lands not part of a regulated unit in British Columbia was 13.7 million m³ in 1989.

More than half of the total land area in Sweden is forested. This circumstance naturally affects the consciousness and traditions of the people. For the average Swede, the forest plays an important role, both as a part of the natural scenery and as a place of recreation. An ancient right gives Swedes an opportunity to freely enter and enjoy any forest, regardless of ownership.

The forest has also from times immemorial affected our culture. It is deeply rooted in the nation's soul. With growing urbanization and changes to the ways of living, the perception and valuation of the forest have changed. For many Swedes with 3–4 generations' distance to the agrarian society, the forest is no more a daily reality. Its very existence, however, is as natural as the air we breathe, whether we are regarding it as a base of our materialistic welfare or as a precious part of our life quality. The awareness of the importance of forestry is undisputable but must be kept alive; information of its goals and means is a permanent activity. The public is receptive to factual knowledge on nature.

The Swedes live close to the forest —and we are very concerned about its well-being.

Table 1 indicates one of the key differences between our countries. While about 75% of the forested area in Sweden is privately owned (about 50% by individuals) the corresponding figure in British Columbia is just a few per cent. In southern Sweden, the individual forest owners are still more dominating — about 85%.

Naturally, this ownership structure has a decisive impact on how forest policy and management practices are created and implemented. Also, because hunting and fishing are, as a rule, exclusive rights of the landowner, integrated resource management is stimulated.

The Forest Act is the uniform base of the public forest policy at a national level. It is a compromise that applies to all owner categories of the country as a whole. However, when the Act is applied in practice, consideration is given to the scale of forestry in question and to local growing conditions (latitude, altitude, etc). The objectives for an individual woodlot owner in small scale forestry in southern Sweden are very different than those for a large scale state- or company-owned unit in the North.

Given our mission to compare British Columbia and Swedish forestry systems, we have found it most meaningful to use the large scale management in central and northern Sweden as an imaginary yardstick. Not to be forgotten is the great importance of the privately owned and often very efficient small scale forestry operations, most dominant in middle and southern Sweden.

Overview of the Swedish forest sector

Importance to the economy

As in British Columbia, this natural resource is a cornerstone of the economy. In total, 225 000 Swedes are directly or indirectly employed in forestry and the forest products industry. The sector is decisively important to regional development in sparsely populated areas. As to the industry, it dominates large parts of industrial life in northern and central Sweden.There are also many towns in southern Sweden which depend on this sector.

The forest industry accounts for more than one-fifth of the total net value of the export and, in comparison to other industries, has a very limited need for imported goods. Approximately one-half of the production of the industry is exported. This gives Sweden a relatively large share of the international market.

With such a heavy emphasis on export, it is of course necessary for the forest industry to produce at competitive prices, while maintaining wage levels comparable to those in the rest of the labour market. The industry is also compelled to pay comparatively high prices for timber in order to encourage the forest owners to grow and harvest wood. This has led to major rationalization in all stages of forestry, from the stump to the shipping office.

The forests

Sweden is a long, narrow country, which extends from the southern Baltic to north of the Arctic Circle. Its geographical position puts the country at the same latitude as Alaska. Even so, the climate is fairly mild and temperate because of the warm Atlantic Gulf Stream.

The state of the Swedish forest is generally very positive and promising for the future. However, from a biological point of view, acid rain is posing a threat in the southern part of the country. Here the major concern is the ongoing acidification of forest soils, mainly as a result of air pollution in Europe. The ultimate solution must be diminishing emissions. Silvicultural measures, such as liming, is helping to delay the acidification process. The best insurance is vigorous forests.

The growing stock — today some 2.700 million m^3, equivalent to an average for the country of 110 m^3/ha — has increased throughout this century. Never before has Sweden had as much forest as now. Annual growth is near 100 million m^3 — treble over the last century — or a little more than 4 m^3/ha as an average, with great variations from north to south. Both standing volume and growth rate will continue to increase all over the country.

Potential cut is based on calculations indicating the level of sustainable harvest. One of the requirements is that cutting should not lead to a decrease in the standing volume in the next 100 years. According to the latest estimate, the annual cut in the 1990's could be in the order of 90 million m^3 (all species, all owner categories). During the 1980's the harvest has been 20–25 million m^3 below this level. However, the annual cut has gradually increased in the past years, except for 1990–91, and is expected to reach 70 million m^3 sk in a few years.

The forest yield is all but entirely utilized. Depending on the phase of the stand to be cut and on tree sizes, the felled trees are worked up for pulpwood (or even fuel wood) or saw logs. Very little waste is left after logging.

The successful development of the Swedish forestry during past decades is mainly due to:

- efficient forest management being promoted all along the line (even small scale forestry), including more intensive silviculture;
- improved seed quality and methods of reforestation;
- increasing volumes per hectare and denser stands;
- actual cut falling lower than potential cut and compound interest effect; and
- implementation of a regulatory framework that ensures appropriate exploitation of the wood-producing capacity of forest land.

In summary, goals and means prescribed in the public forestry policy, defined in the Forest Act and successively amended through the decades, have given even better results than expected. At the same time, the industry's demand for timber — in spite of a steady increase of production — has been lower than anticipated during the 1970's, when the current policy was created.

Forestry policy and legislation

During this century, the ownership structure of forest land has been consistent in Sweden: 50% belonging to private individuals, 25% to the forest products industry, and 25% to the State and other public administration.

Earlier, the transfer of forest land of considerable proportions had taken place from the State to individuals and from individuals to companies. The direction and extent of land transfers has always been strongly influenced by the changes in political opinions and economic conditions.

A pronounced shifting in the ownership picture coincided with the progress of the saw milling industry during the latter half of the 19th century, when the State, after a period of distribution of land to private individuals and the iron industry, started to repurchase forest in some parts of the country. At the same time, the companies, principally in northern Sweden, acquired substantial areas of privately owned land within the course of just a few decades, which today is recorded as company forest. In 1906, an Act passed by Parliament prohibited the companies from buying land from private individuals in the northern parts of Sweden. A couple of decades later, the Act was expanded to include the whole country. Since the prohibition Act came into force, the ownership distribution on the whole has been unchanged.

The oldest statute concerning trees and forest can be found in medieval documents. Of course, the

forest legislation has been influenced by prevailing political currents. One should keep in mind that Sweden, with very diverse social, biological, and regional conditions, has had a varying need for forest legislation over time.

When the forest industry, in the modern sense of the word, appeared in the latter part of the 19th century, Sweden was a mainly agrarian society. The forest was both an obstacle for clearing new agriculture land for the growing population and a condition for survival. Its main importance was in providing building material and fuel wood. Through the centuries, it also delivered raw material for pre-industrial production, such as lumber for shipbuilding and wood for charcoal and tar. Early iron mining required enormous volumes of wood.

The origin of our present forest policy and Forest Act was created in an emergency. Towards the end of the 19th century, the Swedish forests were in a disastrous state. In the north, the selection cutting for saw logs had seriously thinned the growing stock in accessible areas within the range of driveable water courses. In the middle of Sweden, due to the heavy need for wood for the mining industry, the forests were overcut and in southern Sweden the overpopulation had caused extensive clearing of forested land for agriculture and cattle breeding.

Thanks to far-sighted efforts by individuals and institutions and by engaged political activities at national and regional levels, a new awareness of the importance of the forest developed. Our first nationwide Forest Act in the modern sense was passed by the Parliament in 1903.

The basic directive, which still is in force, decrees that the forest owner is obliged to take measures to reforest after final cut. Another basic feature of the forest legislation is that the Act prescribes minimum measures. In practical application, however, the forest owner is expected to do a bit more.

The Forest Act and its instructions of application have gradually been amended, taking into consideration changing opinions of the importance of forests from social and economic points of view, and the growing knowledge within biological and technical fields.

The present policy, defined in the Forest Act of 1979, is directed towards high and valuable production of industrial timber. When passing the Act, Parliament stated that, as a general goal, the gross annual cut should be at least 75 million m^3. In a sustained management, environment and other public interests should also be satisfied.

The Forest Act of 1979 can be summarized as follows:

- Regeneration is compulsory after clearfelling, normally with softwood species. Broadleaved species and natural regeneration are accepted on suitable sites. Planting should normally be carried out within 3 years after final harvest.
- Cleaning of young stands is compulsory, especially to control unwanted broadleaved brush.
- Thinning operations should aim at promoting the growth and quality of the remaining stand. They should be avoided in mature or nearly mature stands.
- Clearfelling of normal and satisfactorily stocked stands is not allowed before a certain minimum age. Low productive stands, however, the current growth of which is less than half of normal for the actual age and site, are to be removed and regenerated.
- To meet demands for sustained yield of individual woodlots, rationing of mature forest to be finally harvested may be proposed.
- Environmental and other common interests should be promoted.

As a rule, clearcut is considered to be the biologically appropriate method of final cut. Natural regeneration instead of planting may be applied only if the site is suitable for that kind of reforestation and if there are a sufficient number of seeding trees of desired species and good quality.

In 1983, the Act was amended and rules were introduced concerning the allowable area of clear felling in proportion to the entire property. Thinning of young stands is now compulsory under certain conditions. Also, working plans are made compulsory for all private holdings over a certain minimum size.

As a matter of principle, Swedish forestry is also intended to be self-financed; that is, basic requirements according to forestry legislation must be fulfilled at the owner's expense. However, when in the national interest the forest owner is asked to meet higher demands than is reasonable from the private economy point of view, financial support may be given through state subsidies. Such support is mainly directed to measures important to regional policy, particularly in the northern inland.

For the present time this state support is more than covered by the forest conservation duty payable by all forest owners.

Administration and supervision

All owner categories, even the State, are subjects to the Forest Act. The National Forest Organization, consisting of the National Board of Forestry and 24 County Forestry Boards, is reporting to the Department of Agriculture. In addition to supervising the Act and extension and contractual services for both plant production and reforestation, the Boards are dealing with state subsidies.

The forest legislation is far-reaching and detailed. At the same time, the supervising organization is efficiently empowered, even at local levels. How is this regulatory framework accepted among the private interest groups involved?

A recent investigation indicates that 90% of the interviewed private forest owners consider it important that the Forest Act be properly implemented and that the County Forestry Boards be engaged in advisory service. About 75% regard the Act as being appropriate. The majority go to the County Boards

for advice. This mainly positive attitude probably originates in the owners' and the managers' traditional responsibility for long-term forest management. No doubt, the tradition since the first act of 1903 is also contributing, ensuring that the national forest policy and its legislation are formulated in democratic co-operation among all parties involved.

An up-to-date data base

A prerequisite for a long-term and consistent forest policy is access to an up-to-date data base. Primarily this base must contain complete information on the resources and the environment, such as standing volume, annual growth, annual harvest and losses. We also need reports on the need for various kinds of silviculture and data for forestry research and the state of the environment.

The key instrument for this information is the National Forest Inventory at the University of Agricultural Sciences, which is responsible for the inventories since the 1920's. The present inventory, 1983–92, is based on a nation-wide, scattered sampling of inventory tracts. Circular sample plots are laid out at fixed points along the sides of these tracts. Half the number of tracts are permanent, which gives an informative picture of the changes that have taken place, such as growth, felling, and regeneration work.

The data base is supplemented by statistics compiled by the National Board of Forestry, industry and various interest groups — all aiming at providing a foundation for strategic planning of the forest resource and at recording the accomplishments of the current forestry and environmental policies.

With some years' intervals, the National Forest Inventory has in co-operation with politicians, industry, forest owners associations, and other parties, set up timber balances. Most important from the policy point of view are the calculations of potential cut and the assessed, future balances between timber supply and demand. In computer-based simulation models, the interaction is shown between the supply of timber, according to alternative management programs, and the forecasted need for timber for industrial and other uses. According to recent balance calculations the felling, both in the short and long term, could be increased considerably, giving the industry possibilities of further expansion.

Research

Sweden's competitive position in the world market for forest products is, above all, based on two circumstances:

1. know-how and emphasis on development of new techniques and products, including the use of processes and equipment aimed at environmental protection; and
2. sound and adequate raw material supply and, in the foreseeable future, no alternative use for the larger part of the forested area.

The forest is our most important ecosystem, having a rich biological diversity. It also plays a crucial role in cleaning the air, maintaining the water balance and controlling the local climate. Our forests have a great recreational value.

It is high priority to remain competitive and to protect this irreplaceable natural resource. For these reasons, government, forestry, and industry have traditionally supported a comprehensive forestry and technical research all along the chain, from the seed to the end use of forest products.

In general, basic research and education of scientists is financed through the state budget, while the applied R & D is, to a considerable extent, sponsored by industry and forestry.

The R & D work is based on some assumptions, such as:

- Demand for wood fibre will increase in Sweden, as all over the world. In the short term, however, we will be facing profitability problems.
- The current acid rain threats to the forest and the uncertainty about the climate change will remain.
- The need for environmental considerations in intensive forest management will be more pronounced. Site-related silviculture will be practised increasingly.
- Surplus agriculture land will be reforested.
- The value of the forest as a recreational resource will increase.

The University of Agricultural Sciences (SLU) has the main responsibility for forest research and for the education of researchers. Direct allocations from the government cover only a little more than half of the total budget. The remaining part comes from research funds or from other sources, which are funding certain research projects on the basis of contractual agreements.

Within the university the research is divided into five big research program sectors, which are governed by research committees. These committees are chaired by the head of that research department. Scientists from related departments and representatives of forestry outside the university are members of the committees. This arrangement aims at involving the consumers of forestry research in short- and long-term planning.

Independent of, but in close co-operation with SLU, the government and forest industry jointly operate R & D institutions for tree improvement and logging operations.

The total budget for forestry research in 1990–91 was SEK 450 million, (C$ 90 million), including administration and premises, distributed as follows:

	SEK million
SLU, forestry faculty and the Logging Operations Institute	approx. 300
The Institute of Tree Improvement, other universities, industry and others	approx 150

This means a total, annual investment in forestry R&D of about SEK 7.0 (C$ 1.4)/m³ felled.

Overview of the Swedish forest sector

Education and training

Intensive and sustained forest production in harmony with the environment and other interests necessitates professional knowledge and skill. The fast development of technique and science and an ever-stronger competition in all fields also result in an increased need both for basic education and vocational training, as well as for qualified knowledge transfer to people already employed within the sector.

An additional reason for well-trained labour is the trend all along the line towards more qualified independent tasks. Such progress is required to recruit the best young people.

Theoretical and practical education and training are designed as an integrated system. We refer to the Figure 1.

After 9 years of compulsory school the forestry student could pass a special 40-week course which gives basic training in forest work, with emphasis on work safety. There is also a 2–3 year forestry curriculum of the upper secondary school, providing basic knowledge of all forestry branches and recommended for machine operators and supervisors. The vocational training of forest workers is a part of the public school system.

The latter route also qualifies the student for the 2-year course at one of three Forestry Institutes aimed at a degree in forest technology. The forest technician has also a good basic education in forest biology.

Qualified forest technicians can proceed to the Institute for Forest Engineers, where emphasis is layed on forest technology and operations. The course is 1 year long.

The Faculty of Forestry at the University of Agriculture Sciences provides a degree (Master of Science in Forestry) after 4.5 years of university studies. It is a general rule in Sweden that higher education is open for everyone with certain general qualifications for university studies, independent of previous formal education. These qualifications can be verified by tests, which are arranged twice a year.

The basic education at the Faculty of Forestry is intended to give the students knowledge, responsibility, and analytical competence that is needed for managing and developing the natural resources connected with the forest. Thus, they should be able to handle biological, technical, and economic problems in the short and long term. The integration of the various phases, forestry, wood processing and use of forest products, and environmental concerns of the forests is especially notable. The Faculty therefore educates students not only for forest management,

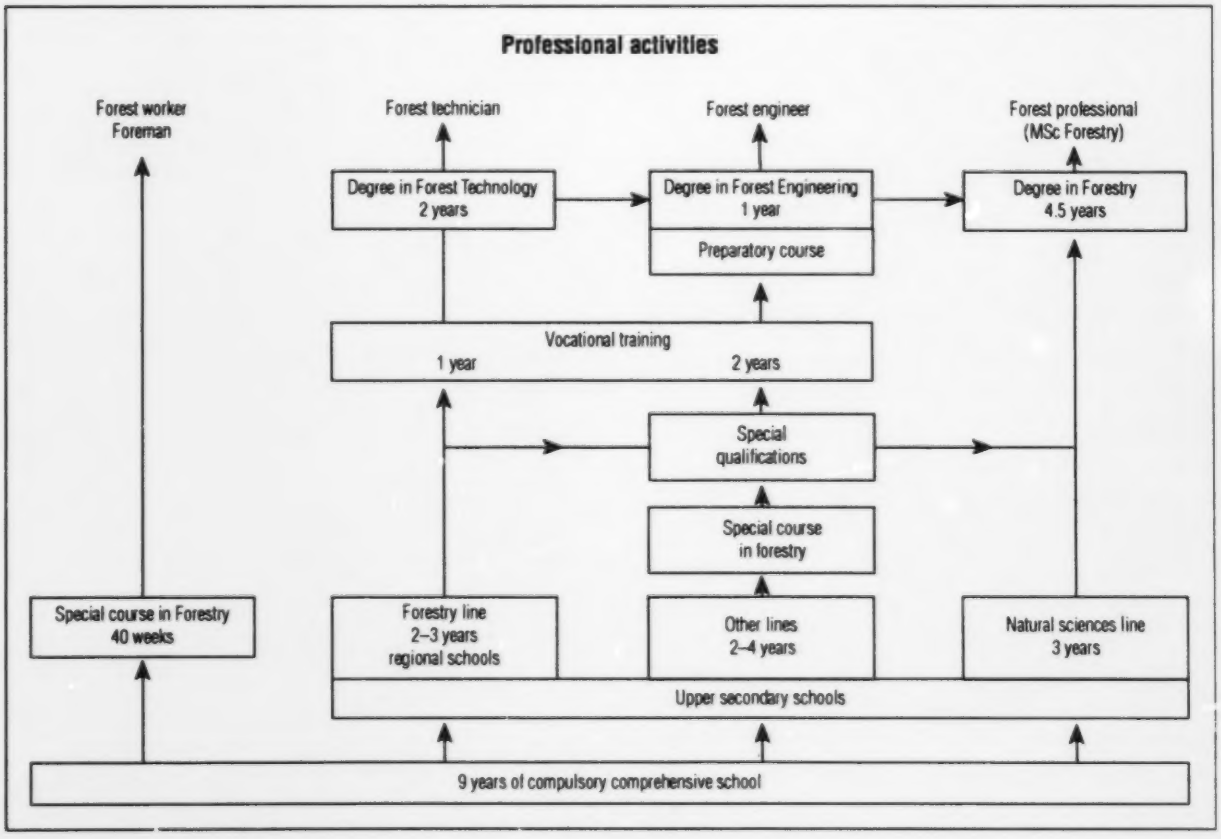


Figure 1. Forestry education.

education, and extension services, but also for other tasks where the combination of biological, technical, and economic competence is essential (tasks such as nature conservation, community land use planning, and assistance to developing countries and research).

The forestry profession is traditionally considered attractive, which means there is competition among qualified applicants for a limited number of study seats at the Forestry Faculty.

Large employers (e.g., the National Forest Enterprise, companies, forest owners associations, and institutions) organize themselves to train employees further. Other employees and self-employed forest owners can attend courses and information days arranged by the educational and R & D institutions, the National Forest Organization, and others.

One example of a nation-wide information and extension project is "Richer Forests." So far more than 40 000 forest owners, forest workers, and other interested people have joined study circles to improve their knowledge of sustained forestry management and "site-related silviculture."

Industry, products and markets

When discussing the Swedish forest industry, one must keep in mind some fundamental circumstances:

- The industry has always been predominantly privately owned.
- It is supplied with timber from its own forests only to a minor extent; it has to buy the balance of pulpwood or saw logs in free competition on the open market.
- The pulp mills are designed primarily to receive and process roundwood directly from the logging areas, but also wood chips from the saw mills.
- The industry is export-oriented under pressure of strong international competition.

The wood fibre based industry is diversified, but in this context we limit ourselves to the principal sectors, sawmilling and pulp and paper.

As in British Columbia, the sawmill industry has undergone dramatic structural changes during past decades. Today, the 300 largest units account for 90% of the production. These large and medium sized mills are highly efficient and many of them are specialized. Kiln drying is a rule and added-value manufacturing important. The integration forest-mill-market is rapidly developing.

Recently, the following ownership pattern within the lumber industry was recorded, related to production capacity:

	Percent
Privately owned independent mills	63
Forest companies	20
State owned(the National Forest Enterprise)	8
Forest owners associations	9

The proportion of privately owned mills has increased slightly during the past decade.

Ever since the rise of the sawmill industry in the 19th century, saw logs have been the economically most important product to forestry. Even if pulpwood has been larger in volume since the 1950's, the main part of the forest owners' net profit comes from saw logs. This is reflected in the main paragraph of the Forest Act, which prescribes that forest land shall be tended, so that it provides a continuous and permanent supply of high quality logs.

Some years ago, Sweden produced 14 million m^3 of lumber — at present about 12 million m^3. The export share is about 70%, of which some 85% goes to western Europe. Our most important markets outside Scandinavia are the UK, Holland, Germany, and France. Sweden is the number one supplier of sawn wood in the European market.

The pulp and paper industry is located in southern and middle Sweden and along the northern coast. The degree of integration and the product mix resemble those in Canada.

Acquisitions and mergers have had still more importance to the ownership and economic structure of this sector. Today's pulp and paper industry is dominated by a few large companies.

The bulk qualities are produced in large units of high technical standard, with very few out-of-date mills now running. The industry has expanded and modernized at a very rapid pace since 1960. The capacity for manufacturing pulp has doubled in that time, from 5 to 10.5 million tonnes. The capacity for manufacturing paper and paper board quadrupled over the same period, from 2 to 8 million tonnes. The structure change has also been dramatic during past decades. For instance, the capacity per average pulp mill increased from 44 000 to 200 000 tonnes from 1960 to 1989, and per paper mill from 30 000 to 166 000 tonnes.

Due to the degree of integration, the export of paper and paper board is proportionately higher than that of pulp. Major markets for paper are, as for pulp and lumber, the UK, Germany, France, and Holland. Seventy-five percent of the total production of paper is exported, of which 80% goes to Western Europe.

The use of wastepaper as raw material in the paper industry has increased at an accelerating pace. This trend is strongly influenced by environmental considerations, not least the efforts to reduce the growing amounts of refuse. In Sweden, as in some other countries, legislation compels local authorities to collect wastepaper, especially newspaper from households. The recovery rate — collection of wastepaper as a percentage of paper and paper board consumption — is estimated to have totalled 45% in 1990, a figure comparable with 38% within the European Community.

In recent years, political and environmental groups have called for the inclusion of wastefibre in the production of various paper grades. The Swedish industry is most decidedly opposed to any form of public regulation of how paper is to be produced. Any such intervention would distort competition and create trade barriers with serious consequences, especially for countries with large net export of paper.

Overview of the Swedish forest sector

Fewer buyers on the timber market, as result of the concentration of the industry, have obviously not changed the pricing system or jeopardized free competition. The regional negotiations between parties representing forest owners and industry, respectively, are following the traditional pattern to settle recommended prices and terms of delivery. The final deal is always a matter of the forest owner or his association and the purchaser, the industrial enterprise.

Large scale forest management

As mentioned earlier, half of the Swedish forest area is owned by large corporations, including the "Crown company," the National Forest Enterprise. The management practices on these properties are carried out under conditions that in some respect are similar to those of British Columbia. These include:

- large contiguous tracts of forest;
- pine and spruce ecosystems prevailing, as in the Interior;
- climate as in parts of the Interior;
- fairly gentle, earlier glacial terrain, as in parts of the Interior;
- strongly industrial forest utilization;
- highly mechanized forest operations; and
- clearfelling of large tracts, dominating as the final harvest practice.

There are also important differences. Compared to British Columbia, Sweden has:

- an absence of very steep forest terrain;
- an absence of the many varied coastal ecosystems;
- company-owned forests that are a valuable supply of wood to the industry;
- a long tradition in sustainable forest utilization;
- a silviculture practice that constitutes a costly but necessary and accepted part of the operations; and
- some corporations that have succeeded in doubling their AAC. Another doubling is within reach in the long term.

The silvicultural practices are simplified and standardized. The principle for stand establishment is to practise standard measures step by step. They have proved to be biologically effective, reasonably low in labour demand, and cost effective. The workers performance is controlled and improved through training programs, work instructions, and assistance by visiting instructors.

Sometimes the striving for simplification has gone too far, at the expense of the biological result — previously a reason for both professional and public criticism. As a result, the training of silvicultural workers as well as machine operators aims at improving not only output of work but also the basic knowledge of nature conservation.

Today's standard treatment for stand establishment consists of:

- mechanical site preparation
- planting of container seedlings
- survival inventory
- brush control
- spacing

Some corporations have developed computerized systems to facilitate the planning, establishing, and monitoring of the great number of management units scattered over vast areas.

Mechanical site preparation – Several types of machines are used — patch scarifiers, disc trenchers, and plows. Mounding has become common practice. The production averages about one effective hour per hectare.

Planting – Planting container seedlings by hand dominates. Half of the work is done with the Finnish planting tool "Potti-putki" or similar equipment. The capacity averages 200 seedlings per effective hour.

Survival inventory – Checks are made 1 or 2 years after planting and often once or twice more before spacing finalizes the stand establishment period, usually 15–25 years. Low altitude aerial photographs and helicopters are common means for inspecting silvicultural works.

Brush control and spacing – These tending measures aim at removing non-desired trees and brush vegetation. The final spacing is usually performed (if necessary) when the plantation has reached 1.5–2.5 m in height. The work is always done with circular brush saws, often provided on a leasing agreement by a dealer, the principle being that the worker should always have a functioning brush saw at hand. The work performance varies considerably; 1 ha per work day or a little less would be a rough average. The total annual area brushed and spaced usually corresponds to about 1.5 times the area clearfelled, which means that the same plantation often has to be treated twice.

Nowadays, silviculture accounts for 30–40%of the total number of man-days used in all forest operations. The example below refers to SCA, the largest company forest owner, with 2.3 million ha.

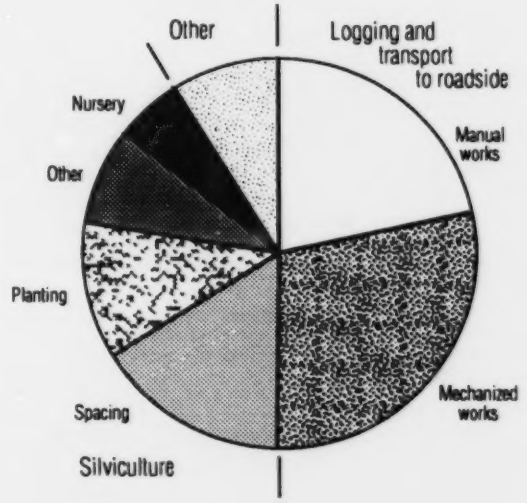


Figure 2 *Approximate distribution of man-days spent per year in SCA's forest (Total approx. 250,000).*

Spacing (including brushing) is by far the most labour-demanding, specific treatment, but field planting and nursery works in total amount to almost the same share (40%) of the total man-days used in SCA's silviculture.

However, all problems are not solved in the corporate silviculture. The works are still mostly manual and the costs have become a matter of concern. A common cost in 1990 was about C$ 10/m³ of wood harvested. This figure includes everything, even forest fertilization programs.

The remedy to the cost increase is mechanization. The development of machines for brushing and spacing has now resulted in many units in operation. To develop a planting machine for the Swedish rocky morainal soils has proved to be a much more complicated undertaking. However, after more than 15 years and many prototypes, financed by a corporate joint venture (also including the state forest) and research funds, a complete machine now seems to be at hand, moving out from the experimental workshop into practical operations.

4.8 Communication and public involvement

The growing awareness that human development must be in harmony with the conditions of nature has highly focused on forestry and the related process industry. In Sweden the public debate has passed through many phases of issues and intensity. The criticism of the sector has been represented at all levels of knowledge and seriousness, from militant groups with diffuse purposes to groups whose analysis is based on science and experience.

All owner categories have got their shares of scrutiny, but the large scale forestry is in the limelight. Above all, management methods such as clearfelling and use of herbicides have been the objects of the public's attention and concern, but fertilization, introduction of exotics (*Pinus contorta*), and draining are also questioned. The media have played an important role in keeping the debate alive.

It may be noticed that the criticism of clearfelling and herbicides to combat undesired brush peaked during the '70's and faded during the '80's. The public discussion of operations within modern forestry has become more constructive due to:

- better knowledge, both with foresters and other interest groups;
- comprehensive government and sector supported information and public relations activities;
- adjustment of forestry from standardized management methods to "site-related" silviculture (i.e., with all measures being carried out with strict attention to particular, natural conditions of the site); and
- statutory restrictions.

Today the public's interest in forestry pays more attention to general environmental and conservation questions than to particular measures. Biodiversity is a hot word. There is also a land use discussion going on, in which conservationist groups are demanding more areas be set aside for preservation and scientific purposes.

Forestry as a whole is closely co-operating in promoting general information to the public. One of many nation-wide projects is "The Forest in the School," which provides courses for teachers and teaching materials, jointly with school authorities.

Generally speaking, after three decades of intensified information being given to the public, we can state that:

- the awareness of the importance of forestry is at an acceptable level;
- the knowledge of goals and means in forestry is improving; and
- perceptions that we have overcut our resources remain.

Involvement of the general public is an ongoing process. A clear and an effective communication will remain as a central part of our strategy.

Observations of British Columbia forestry practices from a Swedish perspective

Some basic comments

From an international perspective, two facts about forestry are clear. First, the global consumption of forest products has increased rapidly during the current century. Most spectacular is the demand for wood pulp for paper making which has risen from a very low level to more than 200 million tonnes per annum. Primarily, the rate of growth reflects expanding economies in industrialized countries, but also the rising world population. According to all international forecasts, the demand for wood fibre material will continue to increase, although at different rates. The growth will be equivalent to an additional British Columbia harvest every 2 years.

The second fact is that the state of the world timber resources has changed. From the beginning, the forest industry's demand for wood could be supplied by forests which Mother Nature herself had created. But there is now a change going on all over the world as the accessible sources of virgin wood are being depleted in region after region. To supply mankind's demand for wood products and to continue the utilization of forest land, harvested forests have to be replaced by extensive silviculture. In Sweden, we reached that turning point 40 or 50 years ago. The new forest now covers a large part of the forest land base.

Checking age of old growth white spruce.

In British Columbia, the original forest is still used to supply the demand for industrial wood. Vast areas of old growth are still left, but for various reasons the need for an enhancement of the forest resource is becoming more and more obvious. The Ministry of Forests has launched a program for "incremental silviculture." The intention is to intensively use that part of the forest land base which is most suited for commercial forestry, taking into consideration other land use interests as well.

In our opinion, this is foresight. It will polarize the land use issue in a sense that nature conservation aspects should have priority to other forest values in some areas, while rational, economic wood production aspects should dominate in others. In contradiction, there is also a conception, both in British Columbia and in Sweden, that we can afford to revert to a forest management that is consistent with conditions prevailing in the virgin forests.

As a matter of fact, the general trend of production-oriented forestry is the opposite worldwide. The rapidly expanding man-made forests are managed according to principles which in many respects resemble those practised by farmers.

Investing in reforestation and silviculture aims at high and valuable timber yield. Therefore, forestry research is largely directed towards such fields as tree improvement for faster growth, introduction of high-yielding species, introduction of disease-resistant species, site preparation, and forest soil ecology. This research, which forms an international web, is very successful. The results will inevitably be applied wherever forests and forest industries are an important engine of the nation's economy. Reluctance to make use of the findings of production-oriented forestry research would result in British Columbia undermining its own forest industry, and allow other countries to move ahead in international competition.

With this in mind and realizing the great economic role that the forestry sector is playing for the province, we think it unlikely that the British Columbia public would seriously try to limit or obstruct the development of incremental forestry over a considerable part of the forest land base. Where the balance should be placed between production-oriented forestry and other resource utilization goals is a socio-economic judgement. In our view, however, intensive forest management — still with due consideration for nature conservancy goals — could be practised on the major part of the accessible forest land base without sacrificing biodiversity.

As critics claim, the ecosystem characteristics of the final phase of the virgin forest, with a great number of dead and dying trees, will not be common where the primary objective of forestry is management favouring dense stands of healthy vigorous trees for industrial purpose. In Sweden, with a long tradition of forest utilization, the scarcity of virgin old-growth forests is deplored by many. On the contrary, in British Columbia it seems obvious that a considerable forested land area will be made into ecological reserves because of their inaccessibility. The general opinion among foresters in Sweden is that a fully acceptable biodiversity can be maintained, even in intensively managed forest areas, except for some elements that are characteristic of old-growth forest. We can see no reason why this would not also be true for the forest areas we visited in British Columbia, provided right management regimes are practised.

Observations of British Columbia forestry practices from a Swedish perspective

The forest debate

The ongoing debate in British Columbia about the appropriate use of the forests shows more similarities with than differences to that of other western countries. No wonder, the critics' sources of inspiration seem to be very much the same. However, the forestry critics in British Columbia appear to be more militant and aggressive than in Sweden, and their arguments are more superficial. One important reason for this difference might be that the information available about the Swedish forests is comprehensive and more detailed in statistical terms than in British Columbia. This is thanks to the existence since the 1920's of the Swedish National Forest Inventory described in Section 4.3. The Inventory is widely used when it comes to political decisions on forestry matters, harvesting, and conservation goals. The Inventory can also demonstrate the historical development of our forests over a long period of time and is fundamental in making projections. Similar surveys exist in other forest-dependent economies such as Finland, Norway, Austria, and now Germany.

British Columbia is Canada's most important forest province, and a dynamic development of the forest estate is under way there. During our visit, we heard many critical remarks on the present lack of accurate inventory information about the British Columbia forest. If this is true, then we think it is very important that the province develop a really reliable and useful modern type of forest resources inventory. We therefore strongly support the Forest Resources Commission's recommendation to establish a Provincial Forest Resource Inventory Committee. One goal to consider seriously could be to set up an inventory based on principles similar to those in Sweden

We have observed the tendency in British Columbia, as elsewhere, to combine viewpoints about forestry practices with criticisms of the biological outcome. We understand the concern in some cases over the negative effects on the landscape when mountain slopes or valleys have been cleared of trees. However, where appropriate reforestation measures have been taken, we see no reason why these would not result in an acceptable new forest of high economic — and even aesthetic — value. Especially on Vancouver Island where active reforestation has been practised for a long time and growth rates are high, the results are often startling by international standards. It is important, of course, in the public debate, if the possibility exists, to demonstrate in numerical and statistical terms the character of the new forest. Again, a forest inventory of modern design would be of great help.

Coastal old growth with plantation in foreground.

There is also a tendency in British Columbia to mix arguments for aesthetic environmental protection with other goals for nature conservation. We noticed that nature conservation areas set aside were criticized by foresters because they would not be accessible for people because of the steepness and remoteness of the land. This is an immature attitude, for nature conservation for nature's own sake is an objective in itself. To save scenic or otherwise exciting nature and make it accessible to the public belongs, in our view, to a different level of nature conservation.

The setting of goals

In this section, we discuss the setting of goals in forestry from pure wood production-oriented viewpoints. In Sweden, with a very turbulent forest history and heavy dependence on the forest as a national asset, goal setting (such as AAC or potential cut [see Table 1]) has been very important for almost 50 years. This is true both on the national level and for our big forest-owning corporations. A basic element for the Swedish AAC calculations has always been the availability of accurate forest data supplied by the type of forest inventory previously described. The implementation of strategies to improve the wood-yielding capacity of the Swedish forest has made it possible to gradually increase the AAC in a way that surpasses all expectations. Finland has shown the same development.

According to a recent opinion survey in British Columbia, the prevailing attitude among professional foresters as to the prospects of sustained supply of harvestable wood seems to be that they are poor (47%) or no more than fair (27%). The risk of a decline in AAC in British Columbia during the next few decades must, of course, be felt as alarming by the forest industry. Sweden had the same situation during the 1940's, a period which led to our first intensive forest management program. As result, a decline never occurred in Sweden. Some forest-owning companies now harvest at AAC levels twice as high as they were 40 years ago.

There are several explanations for the Swedish success. Very important is that the cultivated forests, which now have replaced a considerable portion of the Swedish old growth, yield far more than was

previously expected. We have a strong feeling that this will also happen in British Columbia. In Sweden, like in British Columbia, the first growth and yield models used for predicting AAC were derived from measurements in none-managed or poorly treated natural stands. Tended second-growth forest was lacking at large. The situation is similar in British Columbia. Even here, most likely, the yield expectations on the new forest are conservative. Our view applies both for the interior forest, where the growth rates obtained lie at "normal" levels in the international perspective, and for the coast, where one often finds sites amongst the best in the world for coniferous trees.

A somewhat confusing fact is that existing yield predictions for second-growth forest in British Columbia often refer to commercial timber which does not include natural mortality and small-sized stemwood. The likely addition in future of a pulpwood assortment and tending practices that avoid severe mortality would positively influence some of the yield figures now used.

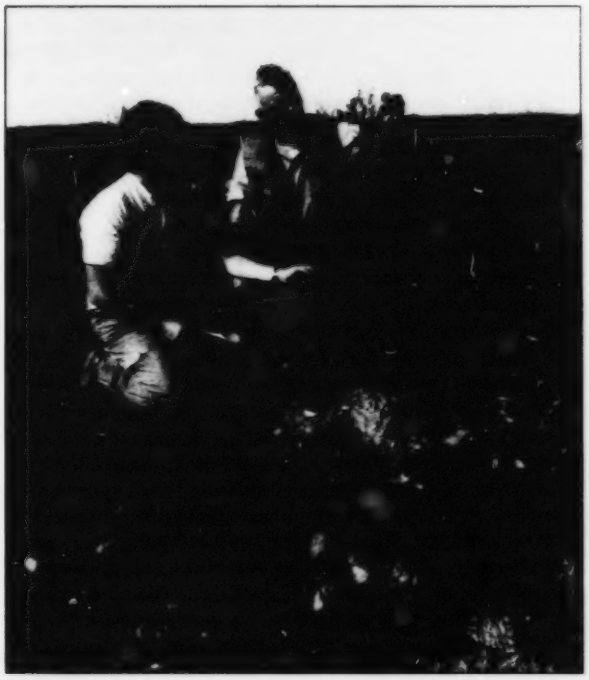
In summary, we have the feeling that, with well-designed and implemented forest management strategies in British Columbia, the AAC levels could gradually be upgraded in the same way as was done in Sweden and Finland. A basic requirement is the existence of a forest inventory which reflects the actual forest situation in detail. Furthermore, there might arise demands for more growth and yield studies in managed second-growth forests.

For many reasons, we are realistic enough to believe that the intensity and the design of the future British Columbia forest industry will be different and more complex than in Sweden. But we are convinced that, based on information from a modern type of forest inventory, combined with realistic forest yield models, British Columbia's prospects for formulating strategic plans are good.

Another key factor for the successful implementation of such plans is the enthusiastic engagement of foresters, industry, and other groups concerned. We fully support the opinion expressed by the Forest Resources Commission that forest tenures, for example, "should provide the greatest security available short of outright private ownership. In return the tenure holder must practise a level of enhanced stewardship that reflects the goals of the Land Use plan." We do not believe that the Swedish forestry results could have been achieved with the combination of forest ownership and faltering tenure policy which until now has characterized the situation in British Columbia.

Present and potential forestry practices

In British Columbia, common practice is to concentrate timber harvesting. Large blocks are clearfelled. In early days, the reforestation measures were often considered to be insufficient. Undoubtedly the situation has improved. Today the new stands are often founded by some type of site preparation and planting. It also frequently happens that natural regeneration is so abundant that the clearfelled area can be left to itself to regenerate.



Lodgepole pine planted on bedding prepared site.

Chemical weed control and manual brushing are sometimes used to minimize mortality and to increase the development of the crop trees. Spacing is practised on a varied but mostly limited scale. Commercial thinnings are very unusual, not in the least because of the low timber value of small trees. Below we give our views on these various practices.

Harvesting and regeneration methods

Obviously clearfelling as a harvesting method is highly questioned by the public in British Columbia and elsewhere in Canada. The critics are suggesting other logging and regeneration systems like so called "selection logging" and "shelter-wood logging." We understand that, so far, very little experience exists in British Columbia in the use of these methods, developed and practised mainly in Europe.

Observations of British Columbia forestry practices from a Swedish perspective

Selection logging

The precondition for selection logging is the existence of an uneven-aged forest where trees of all ages and sizes grow mixed at random. The harvest is directed towards all tree sizes, and a portion is removed at each time. The goal is to keep a more or less stable composition of the stand over time — a "perpetuum mobile" situation. The method also requires a mix of tree species that are shade-tolerant enough to regenerate and develop under canopy. To allow light-demanding trees to regenerate in mixed forests, the method must be modified to allow small openings to form here and there.

From a purely biological viewpoint, the tree species mixture in the British Columbia coastal forest would probably be almost ideal for selection logging. The interior forests on the other hand (with exception of the interior wetbelts) consist of tree species which often do not lend themselves at all to selection harvesting. Lodgepole pine is the best example.

However, selection logging can complicate forest management and raise the costs considerably:

- It demands good professional skill and persistence over generations. Survey and control of the biological result are difficult. With time, the whole activity can become a muddle.
- As timber harvesting is spread over vast forest areas (with small quantities being logged per area unit at a time and with short intervals), there is need for a dense and costly net of permanent roads.
- The best results of selection logging have been demonstrated in small scale forestry where generations of skilled and enthusiastic foresters have worked with the same principles on the same property.
- The market price of wood must be high to compensate for high harvesting and management costs.
- Where the method has been tried practically on a large scale (like in Sweden), the results have often been disappointing. Lack of skill and short-term economic interests have often resulted in high-grading rather than selection logging.

Stagnant balsam on site selectively logged during early 50s.

Considering the general circumstances of forestry in British Columbia, we think it is unrealistic to believe that selection logging will develop into a major timber harvesting method. Even if the managerial and economic problems could be overcome, severe obstacles would remain. Who would take the responsibility for sending men into the coastal old-growth forest to fell scattered colossal trees surrounded by giant dead and brittle snags? The frequency of steep terrain would make such operations even more dangerous.

Shelterwood logging

The other discussed method to be introduced is shelterwood logging, or more accurately, "natural regeneration under shelterwood." A shelterwood stand is formed of mature forest by one or more thinnings. The goal is to form a stand so open that natural regeneration appears and develops on the forest floor. Therefore, the shelterwood stand has the same function as a stand of seed trees: the formation of a new, fairly even-aged generation of trees. A shelterwood stand is just denser. The method has been and is still fairly widely practised in the Nordic countries. It has its pros and cons, of which we would like to point out the following:

- It can be used to regenerate many different tree species.
- Shade-tolerant tree species regenerate most abundantly under mixed seed tree or shelterwood stands. For interior British Columbia, one can foresee, for instance, that alpine fir (*Abies lasiocarpa*) would be highly competitive and, in the course of time, would become a more dominating ingredient in some forest ecosystems than at present.
- The risk for windthrow should not be underestimated. Such experience can be very costly and reduce interest in the use of seed trees and shelterwood.
- The regeneration process can be fairly slow, so the shelterwood stands must be kept under observation for a long time. Failures may be detected too late and can be difficult and costly to repair.
- In the Nordic countries, the method is regarded as most suitable for small scale forestry.
- In large scale operations, a fair amount of regeneration failures have been experienced.

In summary, one saves some regeneration costs, but harvesting costs and overheads may increase significantly. Extra costs of repairing failures can occur.

Even if shelterwood logging is a method that biologically could be practised in many British Columbia forest areas, it is, in view of the general forestry conditions, unlikely that the method will ever become very common.

In spite of the fairly high planting costs after clearcutting, most Swedish forest owners choose this method instead of the more complicated and uncertain regeneration via seed trees or shelterwood stands. Note, however, that the conditions for natural regeneration are usually more favourable in the British Columbia forest than in many parts of

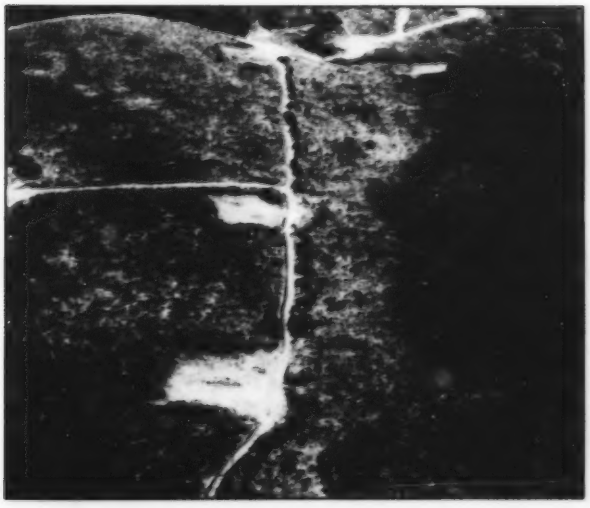
Sweden. This is due to the presence of the prolific tree species and climate in British Columbia.

We believe, that in British Columbia, as in Sweden, infill of naturally seeded trees in the new stand is best used combined with planting, or alone after clearfelling if these trees are sufficiently abundant. Furthermore, shelterwood regeneration can be an interesting method to use, and worth its costs for environmental reasons, when logging occurs close to urban areas or where one wants to obtain special scenic effects.

Clearcutting

Finally, we arrive to the publicly unpopular practice of clearcutting. In British Columbia, like in Sweden, clearcutting is well established. Different is that the Swedes, even if far from wholly in favour of clearcuts, nowadays seem to have accepted clearfelled areas as an unavoidable feature of the forest landscape. Earlier, there was a period of hot controversy on clearcutting, which often was misinterpreted as a "cut-and-run practice." With a normal time span in Sweden of 15–25 years from clearfelling until a closed new young forest is established, 10–15% of the forest landscape consists of cutovers and newly planted areas which look treeless to the public eye. Today, the debate on clearcuts has calmed down considerably, largely because new generations of healthy trees cover vast areas that were earlier been clearfelled.

The aesthetic demands are obvious in conjunction with the clearcutting practice. Deterrent mistakes have been made world-wide: foresters have sometimes been very insensitive. But nature conservation aspects of the practice are even more important. In Sweden there has been a lot done to work out instructions, educate forest personnel, and train workers on how the harvest should be done to care as much as possible about the nature conservation aspects. During our visit to British Columbia, we got the impression that there is much to be done on this topic in the province. Many clearfells show sign of the "golf course syndrome": the cleaner the better.



Clearcuts in the Bowron.

In our opinion there are still many reasons to presume that the clearcutting practice will continue to be the all-dominating harvest and regeneration method even in British Columbia:

- It is a simple, rational, and economic way of harvesting timber.
- It is the only harvesting method we can imagine possible in steep coastal terrain.
- Reforestation measures can take place within a short time sequence. The results are easy to survey, both in cost and biologically.
- Failures in the regeneration process can be detected and corrected in a relatively short time.
- Planting gives foresters the opportunity to decide tree species for the next rotation and to use genetically improved trees.
- The best prospects are presented to form a new forest that maximizes the use of the growth potential of the site. Its composition will make it easy to tend and to manage and its yield will add maximum to the future AAC.

Incremental silviculture: prospects and consequences

During our visit we had the opportunity to see many results of reforestation work (the oldest plantation was more than 40 years of age), both in the Interior and in the coastal forest. We discussed with our Forest Service guides the problems that still exist with the reforestation backlog, which not at the least is due to a large reliance on natural regeneration in the past. With this in mind, we are impressed by the results we saw in places where measures had been undertaken in a professional manner, such as site preparation and planting. Especially on Vancouver Island the second-generation forest now covers massive areas. Most of it, however, is still in quite young age-classes.

Need for enthusiasm and resources

When looking ahead, a key question one must address is how to find ways to create and maintain the right feeling of enthusiasm for enhanced silviculture among the actors on the forest scene. The tenure arrangements, the security of the long-term land use, and the responsibilities must be regarded as very important issues in this context. All of these still, in view of all criticism, seem to lack satisfactory solutions. "Incremental silviculture" including reforestation, tending, and other silviculture activities will no doubt demand an increasing share of labour and become more costly. In Swedish large scale forestry, as earlier described, 30–40% of all man-days used in the forest, including harvesting and transport, are spent in silviculture. Normal silviculture spending is C$10/m^3 of harvested wood. Fifty years ago the corresponding figure was almost nil.

In Swedish forestry, today's silviculture costs are sometimes regarded as too high. Also in British Columbia, even if ambitions are set lower, one can

expect a noticeable increase with time in order to reach the goals set in the Renewal Progam. The reward will be timber of higher value and increased AAC.

Site preparation and planting are now common practices, but other treatments such as weeding, brushing, and spacing are marginal. This is precarious because if untended forests are allowed to develop on the main portion of the harvested area, one can foresee gigantic problems arising in the future. Overly dense young forest stands may grow up causing widespread mortality, a high proportion of small trees, and maybe even stagnating growth. This could occur in a future period when the supply of harvestable old growth is fading out and a huge gap will exist down to younger age classes. Incremental silviculture in British Columbia therefore calls for a massive mobilization of resources, manpower, and money to produce a commercial, reasonably well-tended second-growth forest as soon as possible.

Need for thinnings and forest roads

In terms of expected forest development, we believe that the need for early timber harvest through commercial thinning will increase. This means that round pulpwood will become an important assortment. If so, silviculture should already aim at forming stands suitable for thinning. This would, in our view, lead to denser spacing than at present, at least in the Interior.

Commercial thinning in second growth coastal stand.

The question of thinning leads to an obviously hot topic, namely forest roads. Easy access is an important prerequisite for intensive forest management. Swedish forestry has long since invested in good permanent forest roads which now occur to the extent of 1000–1500 m/100 ha. From what we have seen, and with the exception of major haul roads, the forest roads within British Columbia are below Swedish standards. Incremental silviculture demands permanent roads for easy access, and roads of such a quality that erosion and other negative effects can be avoided. Therefore, we do not agree with the Forest Resources Commission which wants to minimize the number and length of forest roads.

Commercially thinned lodgepole pine. Thinnings used for fence posts and rails.

Need for skilled and cost-effective workers

Incremental silviculture, as an important and expanding activity, calls for the existence of a skilled workforce, both permanent and seasonal. The Forest Resources Commission recommends the creation of a voluntary training program for workers leading to certification, an opinion we highly support. In Sweden, the attitude towards silviculture work has changed drastically. The status has improved, and the work is appreciated as a normal and necessary part of forestry. Now, for example, in large scale forestry it is common that machine operators spend some summer weeks spacing as a physically salutary break from the monotonous harvesting work.

The costly silviculture also calls for targets of efficiency. We have the feeling that the production rate by planting and spacing could be increased at least in the Interior if lighter and more efficient equipment of Scandinavian models were used. The achievements would probably be better per dollar spent. It is a laborious task to change in-grained working habits, but it is often necessary and worth the challenge.

Limited space for pruning and fertilization

With limited resources, it is important to concentrate on treatments that give the best effect in obtaining goals. For various reasons we doubt that pruning will ever become a widespread practice. It might be justified on social grounds in periods of unemployment, but it is so work-intensive that the forestry effects become marginal. This is at least the Swedish practical experience.

Observations of British Columbia forestry practices from a Swedish perspective

Forest fertilization, on the other hand, can be an efficient means to bridge periods of wood shortage. In Sweden, millions of hectares of forest land have been fertilized during the last 25 years, primarily in large scale forestry, with profitable results. Similar effects could certainly be obtained in British Columbia if operations were carried out on a large scale and the effort were used as an ingredient in a strategic plan for an enhanced forestry. However, unlike in Sweden, a limiting factor in British Columbia for implementing large scale forest fertilization programs is low timber value, compared to the price of the fertilizer. This situation might change in time.

Lodgepole pine plantation in the Bowron.

Clearcuts similar in size

On several occasions we were asked how the clearcuts in British Columbia compare in area to the ones in Sweden. Apparently some critics have hinted that the Swedish clearcuts are smaller. This is not true. Swedish large scale forestry dominates half the Swedish forest area. Here the range of clearcut sizes is similar to what we have seen in British Columbia with some remarkable exceptions — the Bowron Valley is one of them. A helicopter inspection of this huge tract situated to the east of Prince George, now more or less completely planted, gave clear evidence that in a few years it will no longer be the world's largest clearfell, but one of the world's largest planted forests.

Prescribed burning or mechanical site preparation?

Another hot issue in British Columbia seems to be prescribed burning. The method is said to be unpopular among the public due to its smoke effects. In Sweden, as a means of site preparation, burning was once widely used. However, several decades ago, it was replaced by mechanical site preparation. The reason was purely operational: machine work is less labour-intensive and cheaper. Our terrain is generally of no hindrance.

Times are changing, though. Environmental research has persuaded forestry that there are reasons to take up burning again. Fire is a natural factor of disturbance in the boreal forest ecosystem. Therefore, prescribed burning should be used on a limited scale to increase biodiversity and to guarantee the survival of some threatened forms of life.

Generally speaking, the biological result of plantations carried out after prescribed burning in Sweden is considered to be good. There were some problems with insects (Hylobius) girdling newly planted seedlings and a fungus (*Rhizina inflata*, also occurring in North America) damaging roots, but these drawbacks are compensated by rapid initial tree growth. Similar positive growth effects can, however, also be achieved with appropriate mechanical site treatment. Nowadays it is not uncommon in Sweden that two or even more site preparation methods are used side by side on the same clearfell.

Compared to prescribed burning, mechanical site preparation gives room for better flexibility when it comes to other nature conservancy considerations. The boundaries of clearfells can be better accommodated for topography and scenery. One can save valuable micro-sites within the clearfell (such as small, swampy areas with the original tree vegetation left) and leave hollow trees for nesting birds and animals.

We are, nevertheless, aware of the differences in clearfells in Sweden and in British Columbia. Difficult obstacles on the ground such as big tree trunks, occur more frequently in clearfelled old-growth forests than after harvest in second growth as in Sweden. Steep terrain of the kind frequently found in this province is another reason to make prescribed burning more appreciated by professionals in British Columbia than in Sweden.

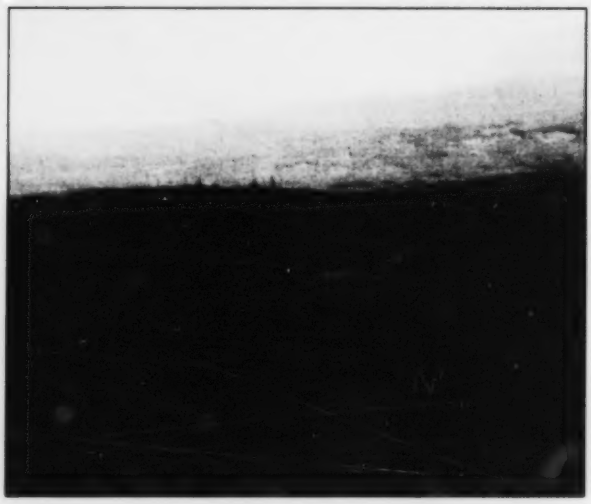
It should finally be mentioned that the Swedish experience of planting directly in the duff, without any kind of site preparation, is fairly unpopular because the planting costs tend to get high. Mortality due to insects and weed competition is also high. Therefore site preparation is preferred wherever possible. We were surprised to know that planting directly in the duff is a common practice in British Columbia and that the survival results are acceptable. One reason for the difference could be the presence in British Columbia of quite a few other possibly more competitive tree species alongside with — as in Sweden — only pine and spruce. Another explanation could be the in-fill of an often fairly abundant natural regeneration.

Observations of British Columbia forestry practices from a Swedish perspective

Brushing and spacing: important and costly ingredients in incremental silviculture

We understand that the forest tending practices that follow stand establishment, as in Sweden, are still in their infancy in British Columbia. For instance, in Swedish large scale forestry the annual area brushed added to the annual area spaced generally covers 1–1.5 times the area clearfelled. These measures are regarded as highly important in Sweden, as they constitute the necessary end-point of the rejuvenation phase. After these treatments there is a certain assurance that almost all the remaining trees will survive and reach commercial size in due time for harvesting.

During our visit to Vancouver Island, we saw planted Douglas-fir stands, now 40–50 years of age.



Sayward Forest. Fifty year-old plantation.

These were, for good reasons, pointed out as the silviculturist's pride, but they had neither been spaced nor thinned. Still, the standing stem volume was impressive. We presume, however, that with incremental silviculture right from the beginning, and if thinnings could have been justified commercially to avoid natural mortality, the yield from these stands would have been even much higher. The fact is that the Island possesses some of the most fertile forest sites in existence worldwide. Our presumption, therefore, is not in conflict with the yield results obtained on experimental plots elsewhere on the Island where Douglas-fir, over the decades, is reaching current increments of at least 25–30 m^3/ha.

With this in mind, we are aware that the Swedish forest tending practices cannot in all respects serve as a model for British Columbia forestry. Biologically the conditions in Sweden are simple. We only deal with two or three different conifers and the span in ecosystems and site fertility is narrower. The forest management goals must also be set differently, according to terrain and accessibility. Forest management in extremely steep British Columbia coastal terrain has nothing corresponding to it in Sweden.

Another difference is the availability of labour for silvicultural work. The situation is probably somewhat better in Sweden than in British Columbia. Even in Sweden, however, the shortage of labour useful for brushing and spacing was regarded as an insurmountable problem once the great demand for this kind of treatment was initially discovered and discussed. But with fantasy and inventiveness, sufficient manpower proved possible to mobilize. This, combined with a massive training program for men and women, made it possible to develop brushing and spacing to the number one activity in Swedish silviculture, in terms of man-days used (see Figure 2).

It is logical that when large scale reforestation programs have been in effect for some time, as now in British Columbia, the next step must be to make best use of the investment through further tending measures — also on a large scale. We can foresee this situation evolving soon in British Columbia.

Therefore, in addition to the remarks above, we would like to recommend that the following points be considered on the eve of large scale brushing and spacing program:

- Recruit steady and reliable labour.
- Develop detailed and easily understandable guidelines for brushing and spacing, always available at the place of work. See to it that the workers and supervisors are well informed on the content of these guidelines and understand the purpose of the work. See to it that they have been trained to handle their spacing equipment efficiently. Poorly performed spacing can ruin all the earlier reforestation efforts.
- Space as early as possible to avoid high costs and to save labour.
- Arrange the spacing objectives in a multi-year plan according to the degree of urgency.
- Keep an even pace from year to year.
- Avoid lag. It will be difficult to make up for.
- Develop a system for continually checking the performance of the single worker. In Sweden we have special instructors which move around to correct and help workers do a good job and increase their productivity.

Seedlings and planting

In British Columbia, an important move to rationalize silviculture was to privatize most of the nurseries. We understand that due to the great variety of forest conditions, a wide assortment of seedling types are needed to meet the demands. The samples of seedlings shown to us were of very good quality. We got the impression that sometimes greater demands have been made upon improving seedling quality than controlling their cost of production. If correct, our suspicion is that the former system, meaning that the province paid for reforestation, could have caused such a situation. In Sweden, the private forest owner has every reason to weigh the cost for seedlings against the survival. As a result, the target in Sweden

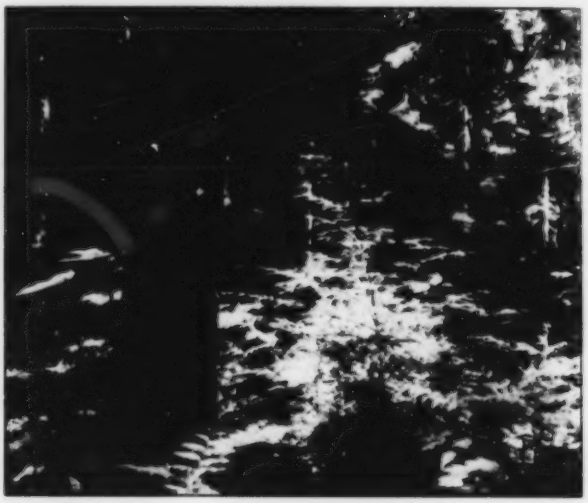
for planting is to get as many surviving well- growing trees as possible out of every dollar spent. With an expanding budget for incremental silviculture in mind, we believe it is important for British Columbia to analyze the planting program from the same point of view.

Container seedlings growing in the nursery.

In Sweden we no longer use shovels or similar tools when planting container seedling. Under Swedish conditions, corresponding to those of the Interior, work performance has dramatically increased when the Finnish planting tube "potti-putki" is used. We are in favour of a price-setting system of planting which encourages high work performance and low costs — again, to get as much successful planting done per dollar spent as possible.

What is the new British Columbia forest going to look like?

Usually the older parts of the second-growth forest in British Columbia seem to be located in more accessible areas and sites. This is easy to understand, considering the harvesting practices in the past. As a result, the remaining old-growth forest to be logged gets increasingly remote and more costly to harvest. It therefore appears likely that the interest in early harvest operations in second growth will increase in time. Such harvest can be done either in the form of commercial thinning or as final felling at an early age. Given husbandry considerations, we believe that thinnings will become common practice wherever technically and economically feasible, especially in the coastal forest. It is common to commercially thin man-made forests in the southern states of the US, in New Zealand, Australia, and elsewhere where similar growth conditions prevail. Why not in the future forestry of British Columbia?



Coastal old growth.

As already discussed, the second-growth forest can be expected to show growth rates which are much better than was earlier anticipated. In Scandinavia, problems with damage by insects and forest fires have decreased drastically as a result of modern management. This will probably also be true in British Columbia. The occurrence of trees damaged by root rot will, however, probably increase, especially on more fertile sites.

The biodiversity typical for the old-growth forest will, of course, change where the new second-growth forest dominates. However, the terrain and the forest landscape typical for British Columbia are very complex and will always, in our view, contain plenty of old-growth ecosystem refuges. Therefore, we can see no reason for a serious degradation in the multiplicity of life forms to occur due to incremental silviculture, provided that due considerations are always given nature values.

Tending practices usually aim at increasing the value of the new forest by lowering harvesting costs and improving tree quality —both, one hopes. We have been surprised to see the very wide spacing which is usually practiced. The argument for this is that further thinnings can be avoided. This might be a correct attitude when foresters are dealing with forests in very steep terrain, but far from always. Widely spaced trees contain knotty wood which definitely is not the saw miller's dream to process. These are the arguments often ventilated by the lumber industry in Sweden.

Observations of British Columbia forestry practices from a Swedish perspective

Research, training and education

It has not been our task to evaluate forest research in British Columbia, nor to comment on training and education. As far as forest research is concerned we would, however, like to point out the importance of studies to support the strategic task of evaluating various development alternatives for the British Columbia forest estate. (The other basis for such projects must be the high quality forest inventory that is due to come.) We do not know, for instance, if the present yield studies for managed stands (pure and mixed) qualify for such use; or if the existence of single tree growth models reflect prevailing natural forest conditions. Natural mortality is a substantial element in the present British Columbia forest and a factor of great importance to incorporate into forest development models. What support can the present forest research give here?

We think it would be worthwhile for British Columbia to consider sending one or two qualified persons as visiting scientists to the Departments of National Forest Survey in Sweden and Finland. The idea would be to study the dynamic forest models these countries use in conjunction with their forest inventory when simulating the consequences of different forestry programs of action. This could provide valuable input for future works of similar character in British Columbia.

As earlier mentioned, many forest workers in Sweden have been educated in special secondary forestry schools. However, temporary workers in silviculture, such as tree planters or persons temporarily engaged in brushing and spacing, have to be trained by the employer. The quality of spacing, however, is considered to be so important that permanent, trained workers are preferred for this type of job.

We cannot determine where the practical limits are of British Columbia training and connecting activities. The Forest Resources Commission realized the importance of increasing activities in this field. Their recommendation is to develop a voluntary training program for forest workers, which, in our opinion, is an important step in the right direction.

Most of the large forest corporations in Sweden have worked out simple and easily understandable manuals for different silvicultural activities. The same is, we presume, true in British Columbia. However, when showing the latest Swedish illustrated work instructions to our British Columbia colleagues, we got the impression that these attracted much attention. We believe that some of these instructions could be easily modified for use in British Columbia, especially in the Interior.

Even in Sweden, the environmental effects of forestry practices have been hot topics for a period of time. Particularly as a result of research, new demands have been made on the planning process, as well as on harvesting and silviculture. Thus, during the 1980's, more or less all personnel and workers in large scale forestry have been involved in training courses in forest ecology, and work instructions have been prepared. With regard to the present-day criticism in British Columbia of some forestry practices, we believe that even here it would be worth giving more direct support to environmental, target-oriented research. Furthermore, we suspect that in British Columbia, like in Sweden, there has been a lack of understanding among the operational personnel and the workers about the demands that modern appreciation of nature values are making on daily forest work. More education and training are probably needed, even here.

Concluding Discussion and Submissions

In a modern society, rich with natural resources like British Columbia, there are several urgent goals. One of them is the achievement of an efficient forestry and expanded forest industry which, in strong international competition, can constitute an engine of prosperity. Compared to this aspect of forest resource management, general preservation of the forest is not a first-hand goal in itself. Environmental and regional considerations according to a sustained development policy should be a built-in part of the sector responsibility of the foresters. This calls for integrated, planned land use and environmentally sound forestry techniques in balance with economic goals.

Forest policy is implemented through various means: legislation, incentives, information, and education. The basic rules are prescribed by law. In addition to minimum provisions, the legislation contains directions concerning environment requirements and other public interests. The forest policy and relevant laws are "long-term rules of conduct." However, the government must have at its disposal instruments for monitoring the effects of implemented policy and management measures for gradually amending the regulatory framework.

In this concluding discussion, we have made the following basic presumptions:

- Forestry and the forest products industry will continue to form the backbone of the British Columbia economy.
- Future policies, formulated in forestry legislation, will aim at achieving efficient and responsible use of the forest resources for the good of the province.
- Forests and forest land will therefore be managed in such a way as to improve the sustained, productive capacity and to secure protection of environment, natural diversity, and recreational values.
- When necessary, the policy will be revised in light of changing social values, new developments, and experience.
- The forest policy and its instructions of application will be created in close co-operation among politicians, the government, the industry, and other groups concerned.

A necessary base for integrated and long-term forest policy is continuous information on:

- forest resources
- industry and demand for timber
- effects of the accomplished policy
- timber balance

A permanent and continuous forest inventory would be the appropriate instrument with which to collect and analyze data for both long-term strategic and operative planning. It should describe the state of the resources, growth, annual cut, and environment. The inventory should also report silviculture measures taken, as well as the need for further forestry actions. It is important that the results of the inventory be officially presented regularly and that detailed data be made available to the public, government agencies, research bodies, companies and others, all according to the customer's specific needs.

Formulating long-term policies and goals must not only be concerned with potential forest production. It must also be based on assessments of developments in various other areas. The key issue in this context is the structure and capacity of the industry and its raw material demand. Considerations must also be given to how the industry can contribute to a growing economy, create jobs, and improve regional development. Industry and trade associations should be closely engaged in this work.

Compiling the timber supply (AAC) and demand data provides the timber balance. The balance can either show the current state or a future situation on given conditions, referring to the province as a whole or regions.

We recommend that:

- a permanent and adequately staffed British Columbia Forest Inventory be established to take on an expanded role with responsibility for compiling and analyzing data for strategic and operative planning. The Inventory should be assisted by an advisory committee representing government, industry, research bodies and other resource groups involved in the management of natural resources.
- the corresponding Swedish and Finnish institutions be studied and an exchange of visiting researchers be considered.
- timber balances for the province and regions be made according to industry forecasts of timber demand and estimates of AAC reflecting various degrees of silviculture intensity.

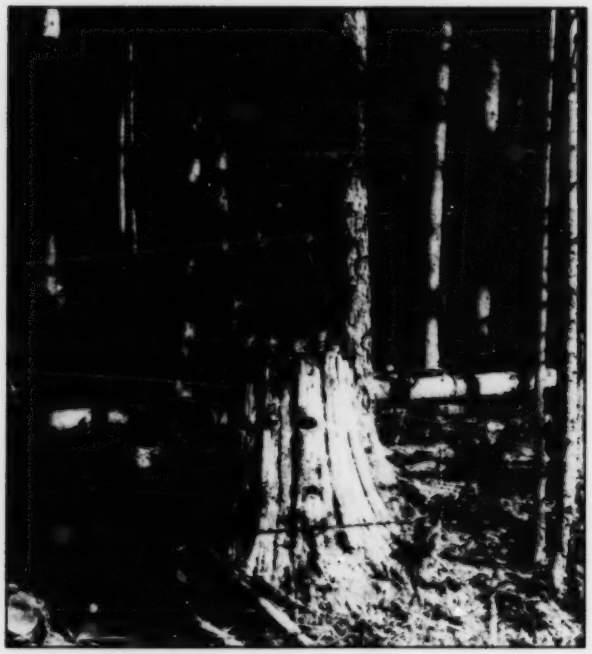
Even in the foreseeable future, management regimes will be dominated by clearcutting and regeneration of mature stands. The age distribution of the British Columbia forest is uneven. The remaining old forest is growing partly in less accessible situations, fragile from the aspect of nature conservation. The cultivated forest is still young but constitutes an important timber resource for the future. Today the growth capacity of this new forest may be considerably underestimated, which in its turn could have a negative impact even on the current felling policy.

The prospects of giving greater consideration to nature and recreational values are obvious, both at the planning stage and during the operation. This emphasizes the need for improved knowledge about growth and yield of the tended forest.

To bridge any gap of supply and to avoid a future shortage of commercial, accessible timber, the assets must be restored according to a long-term, systematic plan. This plan should co-ordinate final harvest of old growth and the establishment and tending of resources to come. Enhanced silviculture will speed up the rate of production and amend the quality of young stands. In an early stage, pruning and fertilization are a lower priority. For the sake of forest husbandry, one hopes that demand for small-sized timber for use as pulpwood will arise.

Fantasy, inventiveness and planning skill will be needed to mobilize and to use effectively funds and

manpower available. The goal must be to get the maximum economic and biological result of every dollar spent.



Second growth coastal stand. Note springboard notch in stump.

We recommend that:

- forest management practices be revised to reflect the increasing importance of the new forest as the future supply of timber and as a changing environment that also has to meet other demands for the forest land use.
- approved forest practices be given appropriate publicity to improve the knowledge of goals and means of the forestry.
- growth and yield projections be prepared to quantify the increment rates of second growth for all species concerned and various sites and management regimes. Losses due to natural mortality are an important parameter when the net output of timber is assessed.

The critics of forestry practices are insisting on alternative harvesting and regeneration methods to clearcutting and planting — alternatives such as selection logging and shelterwood. There are good reasons to assume, however, that clearcutting and intensive reforestation will continue to be the all-dominating management regime in British Columbia. The prospects of giving greater consideration to nature and recreational values are obvious, both at the planning stage and during the operation.

The success of even the most well-planned silviculture systems, however, depends on knowledge and skill at all levels of employment. Information, vocational training, and further training are essential.

We recommend that:

- increased emphasis be given to research on protection of biodiversity, as well as on aesthetic and recreational values in conjunction with rational harvesting and silvicultural systems.
- instructions (manuals) be compiled to stimulate site-related silviculture.
- an educational and vocational training program for silviculture measures be worked out in co-operation with governmental bodies, industry, labour organizations, and other interest groups. The program should include informative and illustrated manuals for field work.

Reforestation and other silvicultural activities will become increasingly costly and labour-intensive. It is very important to create and maintain enthusiasm for enhanced practices among the actors on the forest scene. Tenure systems, long-term land use, timber supply, and responsibilities of the licensees are crucial issues in this context.

We recommend that:

- authorities concerned pay heed to the recommendation by the Forest Resources Commission that forest tenures "should provide the greatest security available, short of outright ownership. In return the holder must practise a level of enhanced stewardship that reflects the goal of the land use plan."
- computerized routines be improved to plan, monitor, and evaluate per object all stand establishments, from site preparation and regeneration to free-to-grow after first thinning.
- the economic-biological relations be analyzed between seedling type/quality (cost vs. survival) and planting/tending tool — work performance (cost vs. survival). Use of more efficient and lighter equipment (e.g., like that of Scandinavian design) should be considered.